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JUNE, 1943

RODALE PRESS

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The Phosphate Problem in New Zealand

By Sir Albert Howard, C.I.E.
Fellow of the Imperial College of Science

IN a letter dated January 20th, 1943, the Honorary Secretary of the New Zealand Humic Compost Club asked me for my opinion on the possibility of compost overcoming the marked deficiency of phosphate in the local soils. Mr. Ashby informed me it is argued as the residues used in composting in New Zealand are raised from defective soils, these materials are, therefore, bound to yield a type of humus deficient in phosphate. He also sent me two highly suggestive papers on serpentine superphosphate by Messrs. Cockayne and Holford which appeared in the *New Zealand Journal of Agriculture* of October 1942 and January 1943.

Although I have never been in New Zealand and have had no opportunity of studying this phosphate problem on the spot and of making a critical examination of the results of the various experiments which must have been carried out on this subject in the past, nevertheless I have no hesitation in complying with Mr. Ashby's request, because I spent nineteen years in a locality, the soils of which were even more deficient in phosphate than those of New Zealand. The tract in question was the Tirhoot Division of Bihar (India) in which the Pusa Research Institute was situated. The available phosphate in the soils of this area is unusually low; on the average about 0.001 per cent. The total phosphate is also correspondingly low. Nevertheless the region in question is known as "The Garden of India"; the soil is highly fertile; this tract maintains a population of over 1,200 to the square mile: large quantities of seeds, tobacco, live stock and surplus labour are exported: there is no import of *phosphatic manure of any kind*. The facts relating to agricultural production flatly contradict one of the principles of agricultural science, namely the need for phosphatic fertilizers in areas where soil analysis shows a marked deficiency in this element.

Naturally, while on the Pusa staff, I became intensely interested in this phosphate problem and delved extensively into the literature. I soon discovered two disconcerting facts: (1) When superphosphate is applied to most soils reversion takes place at once, the soluble acid superphosphate being converted into the insoluble tricalcic phosphate; (2) Basic slag only produces positive results on the heavier types of grassland and is without effect on soils on chalk or limestone formations. Taken together these two results suggested that something else besides chemistry came into this phosphate picture. Clearly soil physics must be involved. This was confirmed by the discovery of a remarkable paper on the indirect effect of manures by the late Sir Daniel Hall in the *Journal of the Royal Agricultural Society of England* in the early years of the present century. I forgot the exact date, but it was somewhere around 1905 or 1906. The Compost Club might dig out this paper and publish a suitable extract in *The Compost Club Magazine*. I discussed the matter with Sir Daniel Hall in 1913, who deplored the fact that no one had followed up this important clue. He readily agreed with me that a large part of the effect of superphosphate might well turn out to be due to the chemical reaction involved in reversion which was bound to affect the soil colloids.

If this explanation is correct, it would follow that almost any mild acid would produce results similar to those obtained with superphosphate. I put this idea to the test at Pusa and compared a dressing of superphosphate at the rate of 1 cwt. per acre with the equivalent amount of powdered sulphur and found the results were identical. As far as I can remember the acid-forming capacity of 10 lb. of powdered sulphur to the acre (when oxidized by the sulphur bacteria in the soil) is equivalent to 1 cwt. of ordinary superphosphate. My results were published in the *Agricultural Journal of India* about the year 1924, but I have no copy of this paper at Heversham for reference. The results of this experiment therefore supported the view that soil physics enters into this question. The acids obviously flocculated the soil colloids and improved the aeration.

About the same time I obtained the explanation why crops in the Pusa area are able

(Continued on inside back cover)

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J. I. Rodale—Editor | Sir Albert Howard, C.I.E., M.A., Honorary Editor

With the Editor

Federal Program

EVIDENCE that piles in from every corner of the earth shows conclusively that man would be much healthier, both physically as well as mentally, if he ate food that was raised by more natural methods than those produced by the highly chemicalized, commercial, present day practices. In this editorial, I want to concentrate on a suggested Federal Program to be put into effect right after the war. It is not the place to write in detail all the things we have already shown in previous issues of this magazine, about the effect on man and the soil of the use of artificial fertilizers, of the killing off of earthworms and beneficent soil bacteria, the erosion of the soil, etc. More evidence will be presented in future issues on this aspect. But we do want at this time to show the need of a program to help preserve America's soil.

The change-over in farming from the artificial methods of today to more natural ways, represents a major revolution in the tilling of the soil, and can be accomplished only in a slow and gradual manner. You can't tear things out by the roots over-night.

My first suggestion is that with the end of the war there may be a serious problem of providing adequate employment to all. Official pronouncements unqualifiedly state that employment after the war is guaranteed to everyone. With the experience gained through the operation of the C.C.C. (Civilian Conservation Corps) before the war, I suggest the formation of a huge land army, an army which will put its shoulder to the soil, an army which will bend its every effort to ferreting out every bit of organic material, most of which is now wasted and see that it is turned back to the soil in the proper manner.

This army would work in the cities as well as in the country. First of all, a comprehensive survey should be made, identifying all waste organic materials available; then a systematic method of attack by the "Army" to preserve as much of it as possible for use on the land.

To cite a few examples: In the Autumn the falling leaves are carted away to city dumps or to places where they are burned. The Land Army would take over the handling of every leaf that falls and bring them to community places where they would be properly composted. Such an

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army could make a search for old dumps where leaves may be found in a finely decayed condition, where leaves may have been dumped for tens of years or more.

The city incinerator would practically be abolished. In a city like Allentown, Pa., there are hundreds of loads each day which come from grocers, vegetable dealers, fish and poultry stores and many other kinds of establishments, all valuable green and animal matter which is burned up each day. This kind of matter if properly composted, in community compost piles, makes the finest natural fertilizer.

City lots as well as country fields grow r a m p a n t with weeds. The ragweed which causes hayfever grows and goes to seed unmolested, although there are many local ordinances which provide penalties in such cases. Alas! these ordinances are not enforced. Imagine our Land Army ripping into these lots and fields, cutting down everything, before the offensive pollens start polluting the atmosphere. What a boon it would be to Hay Fever sufferers and what tonnage of valuable organic material it would yield for our gradually eroding soils.

By keeping weeds down the mosquito nuisance would be abated a great deal. After rains the sun cannot get down to the bottom where there are long weeds standing. The result is, these places are always damp and make excellent breeding places for mosquitos. By keeping these weeds down, and the ground fairly dry there will be a practical elimination of this pest.

Due to the excessive rains last year around Allentown, Penna., the mosquito menace became so bad that no one could sit on their porch in the evening, whereas in a dry summer that was not the case. But even in a wet year, by keeping the weeds down, the sunshine in between the rains would prevent mosquitos from breeding.

Another advantage of cutting weeds in empty lots would be the enhanced beauty of appearance of the city and an increase of real estate values.

Nature takes 500 years to produce one inch of topsoil. In many cases man in one year has destroyed that inch. The Land Army will help nature maintain its top soil.

We s h o u l d have a "Sea Army" also. For centuries the fertility of our soils has been running off our lands through erosion, into the rivers and oceans. We could get some of this back in many ways. The war is building us up as a maritime nation. Our fleet of ships when "the lights go on again in the world" will be enormous. We will have hundreds of thousands of m e n trained in the ways of the sea. Sea weed farming would produce millions of tons of seaweed which decays very readily and makes an ideal fertilizer.

The Sargasso Sea in the Atlantic Ocean is well known for its thick patches of seaweed. Columbus said that he passed through great patches of seaweed "so abundant that the ocean seemed covered w i t h it." O u r army could bring much of this green matter to our soils.

In Mussel fishing, these giant fish when caught by big fishing fleets are cut on the spot. The valuable part is kept for sale, the rest is cut off and dumped into the sea. Hundreds of thousands of pounds of such o r g a n i c matter could be brought to the mainland by subsidizing these fishing fleets. It might be made a crime to throw such matter back into the sea.

These are only a few instances of what our oceans might yield. An investigating body might make a thorough survey of this branch of the subject and yield up dozens or hundreds of other examples of criminal waste of organic matter.

In conversing with the average farmer it does not take much talking to convince him of the soundness of organic farming, but in practically every case he then comes out with the complaint that it takes too much work and therefore is not practical from a dollar and cents standpoint. The vision of turning over these big compost heaps by hand is a nightmare to him. Sir Albert Howard, however, recently advised me that the mechanization of the compost heap has been effected. A machine has been devised which attaches to a tractor and which turns over the heap mechanically. O n e of these machines is now being built in England and will probably be available here after the war. Sir Albert states, however, that on account of its cost, it will be practical only for farms of 200 acres or more.

Here is where our L a n d Army steps in and owns some of these machines. They can come to farmer Smith's farm and turn his heaps for him whenever necessary.

Then there is the question of sewage. In most big cities there are plants for breaking down

and purifying sewage which leaves a residue product of some fertilizer value called sludge. However there are two processes of doing this. The average city has the equipment for producing sludge by the Imhoff process which leaves a sludge of extremely low fertilizer value. The *Activated* process produces a sludge of high value and one which is all organic. The city of Milwaukee turns out such a product which the city itself sells under the name of MILORGANITE. It guarantees it to be all organic.

There is only one question in my mind. In the use of human excrement for fertilizer it has been maintained by authorities that certain virulent organisms, such as for example that of typhoid disease, are not killed off in the composting or sludge-making process. We have written to the city of Milwaukee requesting information on this angle. The possibilities are that in the Imhoff process these organisms are not killed off but that in the Activated process they are. Tests will have to be made.

The Land Army could operate such sewage plants in every city and salvage as much safe fertilizer value out of them as possible. At least such fertilizer could be used for lawns and ornamental shrubbery, etc. and save other safer organic material for food growing.

Another suggestion — This war is training hundreds of thousands of chemists. No doubt post-war needs will not absorb all of them. Why not set thousands of them in special laboratories where only the organic angle of growing things will be investigated. New techniques might be worked out for making compost and for making the soil more fertile by natural means.

Chemurgy

While on this subject of chemists I must say a few words against a dangerous trend in modern American industry and farming. It is a new science called Chemurgy. It is usually referred to in articles and advertisements in the most glowing of terms. Here is a typical advertisement — "Tomorrow a Motor Car Body, a Square Meal and a Suit of Clothes from the same crop!" It talks of the "test-tube of Science," a "storehouse of hidden riches" and "pioneering in organic chemistry."

What is Chemurgy? It is a new word, so new in fact that it isn't in the dictionary yet. Chemurgy is that field of science which is devoted to finding new uses for farm crops in industry. There has been formed a "National Farm Chemurgic Council Inc.," with offices at Columbus, Ohio. A booklet issued by them states that their mission is "To advance the industrial use of American Farm Products through applied science." Their booklet further states that "Farm Chemurgy," liberally translated, means putting Chemistry and related Sciences to work in industry for the farmer, and indirectly, for society in general.

In the long run this new field of endeavor, if not curbed, may ruin the farmer and prove disastrous to society. The historian Ferreri in his great work on history states that Rome fell because of the exhaustion of its soil. The soil was no longer able to support the Roman population. The result is well known to every high school boy who is devoted to his lessons. The Romans tried to make up for it by embarking on a long course of imperialistic war which resulted in a further dissipation of their natural resources. They were finally conquered by the Huns.

One of the arguments of those opposed to the application of organic farming is that there is not sufficient organic fertilizer material available. That is open to question. However, I believe it is the part of wisdom to save every bit of organic fertilizer for the production of food and those necessities of life such as clothes, alcohol, etc. Why try to produce automobile bodies out of soybeans when there is sufficient metal in the ground to last for hundreds of years for this purpose? I am not talking about the necessities of war. Under present-day war conditions it is necessary to get alcohol from cornstalks, to make synthetic rubber, it is necessary to do many other things on farms, but let us get control of this trend right after the war before it turns into a Frankensteinian monster that will rise and destroy us.

Even the advocates of the use of chemical fertilizers admit that one cannot farm exclusively with artificials. Some manure or other bulk organic matter must also be used. So, in Chemurgy, that amount of organic matter used is actually stolen from the regular and legitimate supplies needed to grow our food and other necessities.

Listen to the ravings of a writer in a popular magazine:

"Instead of nothing but

starvation and hard work, we now have surpluses. And this is where Father Chemurgy steps on the stage, gathers in all the little soybeans and the nasty milkweed and the irritating dandelion, waves his wand, and makes out of them the most beautiful baby carriages, aviators' suits and rubber balls you ever did see.

"Ain't nature wonderful, my eye. Ain't man smart?"

In the opinion of that writer, man is smart, but when you see how readily the average person accepts published statements without thinking for themselves, especially when they come from so-called authorities, one begins to wonder whether man possesses the seven brands of wisdom.

It is of the utmost importance that as soon as the war is over the Government make a study of this new field of Chemurgy to see whether any curbs are necessary in the interests of the public.

Earthworms and Crops

By Sir Albert Howard

A simple method of estimating progress in the building up of a fertile soil is to observe the growth of the earthworm population. As the humus content of the soil improves the number of worms markedly increases. This is due partly to the addition of humus, on which the earthworms feed, partly to the effect of this humus in increasing crop growth and so providing more food for these animals, and also to the direct effect of the earth-worms on the crop itself.

That the crop is influenced by the earthworm is proved by some observations I made in the great potato area in the Holland Division of Lincolnshire a few years ago. While studying the root development of the two common varieties of the potato grown in this tract, one of which (Majestic) was more resistant to the potato leaf disease than the other (King Edward), I confirmed my surmise that this difference in susceptibility to disease would be associated with the root development of the two varieties. I expected to find Majestic was provided with a superficial root system, King Edward with a much deeper one. This proved to be the case.

Now in pursuing this enquiry it was necessary to make accurate root maps in the soil profiles. This can best be done by converting an ordinary knapsack spraying machine with its diffused spray into a machine which will provide a needle water spray just strong enough to remove the soil particles without injuring the roots. This is easily arranged for by changing the nozzle. In this way it is possible to expose the roots of any plant on the vertical soil profile and to draw an accurate map to scale of the root distribution.

In the course of this work I frequently came across the tunnels of earthworms in which fresh worm casts had been deposited. The potato roots were also using these tunnels to reach the deeper soil layers. Whenever one of these fine unbranched roots passed these fresh worm casts the root branched, forming a fine network closely surrounding the casts. Obviously they were absorbing something from these casts, otherwise this extraordinary root development would not have occurred. It was not possible at the time to carry the matter further, but here is obviously the starting point for a new investigation which is certain to carry one step further the story outlined in Darwin's well-known book on vegetable mould.

At the present time we cannot know too much about the earthworm and its relation to soil fertility and crop production, because of the onslaught that is being made on these indispensable creatures by the vendors of artificial manures and poison sprays. Many of these manures, sulphate of ammonia in particular, and some of the fungicides and insecticides such as lime sulphur and tar oil destroy the earthworm population of the soil wholesale. This is one of the harmful aspects of plant protection which has passed almost unnoticed.

My Experiment With Chickens

By J. I. Rodale

THE modern commercial method of chicken raising is producing devitalized chickens and devitalized eggs, and is bringing about a condition of disease and cannibalism among chickens which is truly alarming.

Before chickens were domesticated by man, that is, in the wild state, a chicken would lay about 20 eggs a year, would roost in trees, and scratch for its food which would consist for the most part of green plants, earthworms, insects, etc. How are chickens raised today? In the first place by a system of the gradual selection of the best layers for breeding purposes there has finally been perfected breeds which lay as high as 300 eggs a year or more. Can you imagine the effect on the organs of a chicken which have been turned into a laying factory? After all, every organ of the chicken contributes its part to the making of an egg. What would be the effect on the health of a woman if by selective breeding she was enabled to have a baby every month instead of every year?

Secondly many of our chicken-raisers keep their chickens penned up indoors without benefit of the outside sun and fresh air. Recently I visited the chicken lofts of a large farm and was almost knocked out by a vile odor that smelled of ammonia which comes from the chicken droppings of chickens that never leave the poultry house. Worse than this, there are farmers who raise broilers indoors in batteries (cages). These chickens only leave these cages to go to the chopping blocks. Many such places are in cities, even in factory buildings.

Third—the diet of the modern commercially raised chicken consists mostly of purchased mashes which is a far cry from the natural diet of the chicken in her native haunts. These mashes are made up of formulae of foods designed to high-pressure the chicken into laying her head off. (I have actually seen chickens which have become bald-headed due to excess laying). These diets include grains, meat scraps, cod-liver oil, vitamins, etc., but the fact remains that on this artificial regimen chickens today are plagued by many diseases. Poultry scientists are at their wits end diagnosing and trying to keep such diseases in check. At many farms you will see some dead and paralyzed chickens around the poultry houses all the time. Medicines are being continually forced on chickens to flush the diseases out of them.

A few years ago a friend of mine, raised chickens indoors. At the age of nine or ten months they started becoming lame and when killed it was found that their livers had swelled to six times the normal size. In the meantime the family had been eating the eggs of these chickens.

A few years ago at the railroad yards in New York City where shipments of chickens arrived, so many of them arrived dead and badly diseased, that a group of men called *shwogies* were on hand at all times. They received these chickens free in return for the labor of taking them away. These chickens found their way into the bargain poultry markets. I understand that this practice has been discontinued.

There are many other questionable practices which contribute to making the present day chicken a liability to society and a food product which must lack in vitamins and nourishing qualities. One of these is the lighting up of the laying houses for extra periods to stimulate more egg-laying. I have heard of methods of forced feeding to fatten chickens before sending them to market. There are others.

Some time ago I heard of an idea which had been tried out in California, a method of

feeding earthworms to chickens which aroused my interest and which we discussed in detail in the March issue. A pit is dug under the chicken roosts and in it are placed a large quantity of earthworms. The late Dr. Oliver of California suggested 50,000 earthworms for every 100 chickens. This may sound like a lot of worms, but I have read that such a quantity can be supported in a cubic yard of earth, and costs about $100 if purchased from earthworm breeders.

The chicken droppings fall into the earthworm pit and make an ideal food for the worms. A wire netting prevents the chickens from getting into the pit, which must be kept moistened as the worms like moisture. As the worms multiply they work out through the sides where the chickens can get at them. It is a beneficent arrangement which is mutually profitable although both the worm and the chicken lose out in the end. At our farm we are now making arrangements for such a pit and the earthworms have already been ordered. There is a question whether this method which seems to have worked in California will work out under Pennsylvania climatic conditions, especially during the winter. We will know by next spring and will keep you informed.

There is another method of feeding earthworms to chickens which we are working on and which has been suggested by the Ohio Earthworm Farms. I believe this method will work out to be very practical. We obtained two boxes of breeding worms, 1800 worms in each box. The boxes measure 13½" x 16" x 6". We feed them once a week, each box getting one tablespoonful of sugar, one tablespoonful of corn meal and some suet (meat fat). This is placed on the top of the soil in each box and the worms will eat it up in three or four days. The boxes must be kept well-moistened. Milk bottle rinsings are good for this purpose.

At the end of 30 days the material in the boxes are split up. Out of the two boxes then come four boxes. We take half of the material out of each box to start another box. The empty portion of each box is filled in with rich earth, compost and a little green matter such as grass clippings, leaves, etc. At the end of each month the boxes are divided. Starting with two boxes on April 1 we had four boxes by May 15, eight boxes by June 15, and will have sixteen by July 15, and thirty two by August 15.

On September 15 when we come to divide the boxes we will take one box and feed it to the chickens. This would leave 31 which we would divide and out of which we would make 62 boxes. On October 15 before dividing the boxes we would take 31 boxes and set them aside to feed to the chickens, one for each day of the month. The remaining 31 boxes would then become 62 which would remain a constant figure, allowing a box of about 1800 earthworms for the chickens each day of the month. These figures may be figured to suit your own requirements.

The possibilities seem fantastic and remind one of the pipe-dreams of amateur rabbit raisers with the important difference, however, that earthworms are much more easy to raise than rabbits. From what I have seen thus far I am certain that the figures indicated above will work out. The boxes are kept in a cellar and the tending of the earthworms and watching the way they work makes a most fascinating hobby.

Earthworm raisers claim that chickens raised on an earthworm diet are extremely healthy and this health is usually reflected in the beautiful appearance of the birds. One raiser claimed that their flock became so fine looking that they couldnt get themselves to kill any of the chickens.

Dr. Thomas J. Barrett of Roscoe, California, recently wrote us:

'Regarding use of earthworms for chickens, I kept a small setup of chickens for over a year, following the directions as given by Dr. Oliver. I proved to my own satisfaction that the claims made by Dr. Oliver were correct."

Another method is to use a large outdoor pit instead of the small boxes. No doubt a great deal of labor can be saved in this manner, although the process would stop in the winter time due to the freezing of the ground.

There is still another way with chickens and earthworms which I stumbled upon quite by accident and which may lead to something of importance. At the moment it probably is practical only with small flocks up to 60 or 70 chickens. In my first venture with chickens last year, they were housed in a place which had a small outdoor pen. There were about 20 hens and the outdoor yard which had an

earth floor measured about 100 square feet. The results obtained were poor.

This year we made a much larger outside yard in two parts with a trick door arrangement at the little door where the chickens come out of the "house." This door arrangement is contrived in such a manner that by an adjustment which takes less than a minute we can control which yard the chickens will use. The thought behind this arrangement was that while the chickens were on one side we would be growing a crop in the other. When we switched sides and let the chickens into the pen where the green stuff was up about 6 inches, we would then start a crop on the first side.

Where plenty of land is available so that chickens can roam on grass, that is the best method to pursue but what I shall describe is best in cases where land is limited. The above arrangement, however, did not work out. When the hens were allowed to get at the crop, it was a sight to behold. The way they attacked it reminded me of a plague of locusts. In less than a day, they had cleared everything off and since it takes a few weeks to grow a crop, I realized that this plan would not work.

There are about 60 chickens and each outside pen comprises about 300 square feet. I decided to continue my experiment by allowing the chickens to use one side for about a week and then to change over to the other side for a week and so forth, for purposes of cleanliness. Last year where the hens had access to one pen only things got to a pretty sloppy mess, what with their droppings, the hard crusting of the surface, and the mess created by rains.

At the end of the first week we went into the pen out of which the chickens had been taken a week earlier, for the purpose of turning over the earth so as to get rid of the droppings, but I saw no droppings. Did the rains wash them into the soil? Did the earthworms consume them? We proceeded to turn over the whole pen to about half or full shovel depth. We then let the chickens in and what a field day it was! By turning it over many of the earthworms were exposed at the surface. Hundreds of them right there for the chickens to grab off.

One would get a worm and start running with it chased by a half dozen others trying to intercept. It was not only more fun than a barrel of monkeys but the exercise the chickens got was very valuable for them. After the chickens had been changed over a few times I found that the earth softened up to a remarkable degree and the earthworms multiplied considerably. Upon changing the chickens over, after satisfying their appetites for earthworms, they would nestle down into the soft earth and take a dry earth bath which is an excellent measure for keeping the lice in check. I noticed that the first time I used a shovel to turn over the soil it was hard and took an effort. After a few times the ground became progressively more and more soft. It is now a pleasure to turn the soil.

The drainage has improved immensely. Instead of a muddy condition, the rain is able to drain off quickly. The cleanliness of the surface is

FIGURE 1
When Pen 'B' is in use

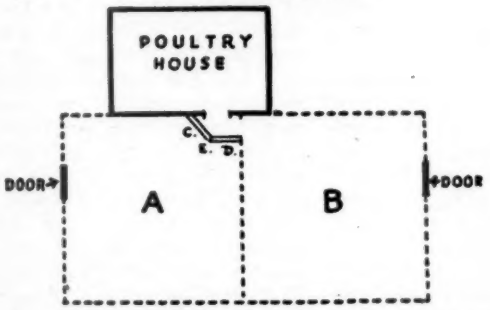
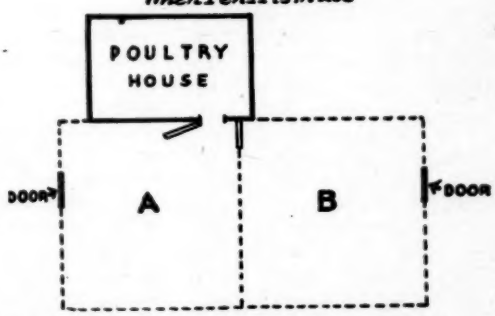


FIGURE 2
When Pen 'A' is in use



The pictures show how the special doors operate. After the chickens have been in pen B their allotted time, door E is unhinged at point E and swung back against the building. Then door D is closed. Now the chickens can go into pen A only.

very comforting. When we throw scratch in these outside pens now, they fall on a clean surface, and not into slop filth in which the chickens must scratch. And, by the way, our scratch which consists of wheat, corn, oats and sunflower seeds, was raised on our own farm without benefit of artificial fertilizers.

One more thing. The place I have been describing was designed only for the brooder flock. At the age of two months they are supposed to be transferred to another setup. On account of war conditions the other place wasn't ready and as the place became cramped we killed a few of the chickens, then opened up our trick doors and allowed the birds the run of both pens at the same time. Every day, however, we would go in and turn over the soil in various places, so that the chickens could get at the earthworms, and they did get them by the hundreds. So, if you have an outside pen you can start right in turning over the soil if the pen isn't made of cement. Remember, the chicken droppings will make the earthworms multiply fantastically. One more angle. A chicken should have fresh green matter as much as possible. So we would shovel up some clover which was growing into the pen. We would dig our shovel under the clover so that it took about an inch of earth along with the clover. We always managed to get a full shovelful at a time. We would throw this into the chicken pen. And would they make short shrift of it! There was always a worm or two in the earth of these clumps. There are other valuable things that the chickens seem to get out of the earth in these clumps, such as earthworm eggs, small insects and their larvae, and other things which must be natural for chickens. They eat off all the green matter in a clump in a minute or two and then flatten out the earth.

As far as what I have described is concerned it is probably practical only for the home flock. But, in time, we may be able to develop out of it something or some method that would be applicable to large, commercial flocks. We also believe that this method would be especially adaptable for turkeys, as they are so much more difficult to raise than chickens. The mortality is so great that most turkeys in captivity are kept off the soil, but walk on wire mesh.

As we observed the actions of the chickens, and the earthworms in the clumps, we noticed one day that where we had had a pile of corn cobs and stalks for over a year, there were earthworms under the piles by the thousands. Look around your place. Whereever there are piles of green matter laying for a while you will be able to see earthworms in large quantities. One shovelful, might contain perhaps 20 or 30 worms. We now throw about 1000 earthworms from the outside of the pens to the chickens each day and it doesn't take too long. We will use this method until October 15, when our earthworm-in-boxes experiment should start to produce.

Another advantage in throwing clumps is that it includes very rich topsoil which enriches the inside of the pens. At a later date I will describe a method of replacing the soil from which the clumps were removed.

I now began an earthworm hunt around the farm. Remembering that last fall we had layed down an 8 inch thick mulch of various materials in a clover field to smother out weeds and to furnish green manure for the next crop, I examined the earth underneath for worms. We had used three kinds of mulch material, thin hay, corn stalks and buck-wheat straw. Under the thin hay and corn stalks there were earthworms aplenty but under the buckwheat straw practically none. I had my observations checked by another person to make sure.

There are two things proved by the application of this mulch. First the mulch must be thick enough to keep most of the air out so that there would be a permanent moist condition underneath. The thin hay and corn stalks fulfill this requirement. It was quite moist underneath them. That is why I found earthworms under the piles of cobs and stalks. There the condition of moisture was even more pronounced. And here I want to make another observation. The first piles of cobs and stalks referred to were about three feet high and the earthworms there were almost white which was because of the excess moisture. Under ordinary conditions and under the one-foot mulches referred to the worms were brown and red.

Under the mulch of buckwheat straw there were very few worms because it wasn't as moist as in the other places. Buckwheat straw is coarse

and hard and does not pack down as well as the other materials.

Point No. 2 What is happening to our land by reason of laying down a mulch? We have a 10 acre clover field that we are preparing for corn. In the fall of 1942 we layed down the mulch above referred to figuring that it will lie for the entire year of 1943 and be used for corn in the spring of 1944. The right kind of mulch, then, would enrich the field with earthworms who seem to thrive and multiply under such a condition. It would trap a lot of moisture, keep the surface of the soil in good tilth, soft and friable. Some of the mulch would rot during 1943. The rest would furnish green manure material.

Is such a method practical for the farmer who has to make a living out of the soil? The answer is first, he would be recompensed, in part, by increased yields. But look back to the over-production days of the depression when crops were plowed under, with government subsidies, when warehouses did not have sufficient capacity, when prices were forced way down. Why not a Government subsidy for a field fallowed with a mulch?

Such a practice as that described above would keep production in check, raise prices for the farmer and result in producing a more fertile soil and prevent erosion.

In the next issue I will describe several other theories and developments in connection with the use of earth for chickens. In the meantime I trust some of our readers will experiment along the same lines and write us of their experiences.

(To be continued)

The Chemical Fertilizer Shortage

ARTIFICIAL fertilizers are becoming scarcer. What can the average gardener do without them?

Thinking over the matter, you will recall that it wasn't very long ago that artificial fertilizers were invented; some student poured a powerful acid over bones, rock phosphate, and other substances. The resulting powder, when applied to plants, caused much growth. It has taken almost half a century of careful investigation to show that this growth was faulty and deceptive, that the plants which these powders produced were soft, watery things lacking in many important vitamins and with questionable food value.

What about the gardeners who worked before the invention of these artificial substances? You get to dreaming about these ancient gardeners and their fabulous gardens.

If you have travelled, you will know that there exist today gardeners in many parts of the world who use the ancient, organic method of gardening. They have fine gardens. The use of chemical powders has, fortunately, not been accepted by them.

This modern, western trick of saturating food plants with solutions of chemical fertilizers, meanwhile protecting their rank growth with chemical sprays, has its parallel in a vicious method of "fattening" oysters.

It took epidemics of typhoid to expose the method. Public Health authorities finally traced the epidemics to the eating of raw oysters. Interested, they found large quantities of live oysters—at least, most of them were assumed to be alive—were unloaded into large tanks built in cellars under restaurants.

Here the oysters, under the most unsanitary conditions, were "fattened" by being forced to exist in dark, polluted, stagnant water into which had been dumped large quantities of wheat flour. In a few days the oysters—those who had not died and rotted in the process—were very bloated and very sick. They were then served *raw and unwashed* to a deceived public regardless of the possibility of spreading disease.

Artificially bloated foodstuff is easily recognized, whether you eat forced oysters or consume vegetables bloated by the use of water saturated with chemicals. It lacks proper flavor; tests will usually show the material to be quite lacking in its normal food value.

Getting back to this matter of the shortage of artificial fertilizers: your standpoint is the

average kitchen garden. From this extends two branches of practice, two schools of thought. These are the chemical method of gardening and its antithesis, organic gardening.

As you know, this matter of successful gardening is of the gravest importance. It has many deep implications. Many gardeners think of gardening as something of a religion. It gives them a certain spiritual uplift to meditate and to observe their gardens when they are down at heart. Their gardens comfort them when things go wrong with their lives.

From the more practical angle, you know that it is very important to understand and practice the best method of gardening, for you know that it is only by this method that you can produce your own vegetables and be confident that your product will be wholesome and fit for food for yourself and for your family.

It is most important that you can use that method of gardening which will not deplete the thin layer of humus in which your plants grow.

You take a look at modern, chemical gardening first. You find that fertilizers, used only sparingly when an occasional hurry-up crop was needed, have been greatly increased. You find a corresponding increase in the use of chemical insect sprays. You find also that the matter of water supply had to be stepped up, irrigation introduced. You find that in the practice of chemical gardening, the more the method was extended and intensified the more acute became the difficulties of using it. The problem of the control of fungi and insect pests increased.

And that causes you to remember that many of the great blights and many of the insect pests which today curse all Victory gardens were unknown a century ago. Why should this be? Why should the attacks of bacterial blights so closely coincide with the introduction of artificial fertilizers? Why should potato blight, for example, suddenly develop into a major menace about the time that artificial fertilizers came into general use?

In your investigation you note that chemical sprays aimed at reducing insect attacks finally became a limiting factor in the pollination of plants. You find that in many large, up-to-date, apple orchards in New York State it is a recent practice to pollinate the trees by hand. A collossal job, if there ever was one, hundreds of women pollinating thousands of apple trees simply because of the ill results of chemical insect sprays found necessary because of the rank, soft growth largely brought about by artificial fertilizers.

In its most extreme form, hydroponics, you will see chemical gardening brought to its logical conclusion. You will find plants produced under glass, air conditioned, artificially pollinated, entirely without natural humus, and almost entirely without food value.

A study of hydroponics might cause you to recall that much has been done in recent years to produce fine looking, new types of vegetables and fruits but that any effort to produce vegetables or fruits of *finer flavor or greater food value* seems to have failed. You consider the fragrance and rich flavor of the humble little wild strawberry as compared with the almost tasteless, large-berried cultivated kind. You wonder how much this general loss of flavor and food value might be attributed to the use of artificial fertilizers.

You look over a garden where the chemical method has been used exclusively. During the first year or two, this garden produced large quantities of apparently normal plants. But what happened around the fourth or fifth year? Unless the soil was exceptionally rich in natural humus the plants failed to grow. They failed even though supplied with excessive amounts of water and chemicals.

You examine this depleted garden. The top soil has become a scanty layer, most of it sand and stones covering a stony subsoil. Then it is that you realize that the actual material required for plant growth is the fertile humus, the material which has been used up. No amount of water containing mineral salts (artificial fertilizers) can take its place.

Such a condition could not have developed by using the organic method of gardening. This method appreciates the fact that certain elements in the topsoil are used up through the growth of plants and this material is promptly replaced.

By seeing what is wrong with the chemical method, you get some idea of the immense value of the method used in organic gardening. Nowadays, wise gardeners tend to

use artificial fertilizers less and less and to place more dependence upon the liberal use of mature compost humus to replace garden loss. They realize that this is essential because the humus used by the plants also continues to be broken down in the natural course of events.

You look over organic gardening. Here you find that with its application artificial watering has been reduced to a memory. Chemical insect sprays have been discontinued because there was little need for them. Irrigation was found unnecessary because the rich, composted material in which the plants grew held enough natural moisture rich in plant nutrients.

As you know, organic gardening is a very ancient system. Men understood its principles and probably understood how to compost waste garden materials many thousands of years ago. They used this method long before the invention of chemical fertilizers. Gardeners will use this method long after chemical fertilizers are forgotten. If you use the organic method exclusively you will find that you can forget about a shortage of chemical fertilizers. By using organic gardening methods you will be able to grow vegetables far superior to those produced by other methods.

By using the organic method of gardening you are assured that the vegetables you produce contain their natural quota of food value; you can be sure that your garden will retain its natural vitality.

You take a farewell look at chemical gardening. You find it worth while to note that there has in recent years appeared, for example, a new disease of potatoes. This disease attracted nation-wide attention. It consisted simply in the formation of a hollow tuber. Unfortunately, this hollow tuber made possible a new focus of infection for other more virulent diseases.

Much investigation followed its discovery, and although it has not been openly admitted, there seems little doubt that the growth of these faulty potatoes was caused by "improper moisture conditions." Actually, this really means that the potatoes were grown in poor soil and their growth encouraged by the use of large quantities of artificial fertilizers and floods of water. You realize instantly that potatoes "blown-up" to such an extent that their centers were hollow could have little actual food value.

Will the absence of chemical fertilizers be mourned? It will not. The lack of artificials will mean an end to synthetic vegetables, an end to the production of deceptive plant material having little food value. It will mean a return to the older better method of gardening, organic gardening.

In conclusion, you realize that the absence of chemical fertilizers will be about the best thing that has happened to gardeners in many a decade. Bloated, unhealthy plant growths will no longer be grown. In their place will come vegetables which are really edible and flavorsome.

Gardeners will return again to that fine and ancient art, organic gardening.

Wood Ashes

Gardens can be greatly benefitted from the wood fires that have been crackling all along through the past Winter in the heater in your living room. I use all the wood ashes I have on my garden. In early Spring they are broadcasted as far as they will go and plowed under. It is best to keep them in a dry place.

I find that wood ashes are a good source of potash and lime, and they also contain phosphate. They are not a complete fertilizer, however, because they are lacking in nitrogen which is essential for most soils. If needed, and it usually is, it must be obtained from some other source. I find that well rotted stable manure is best, if available. Droppings from the poultry house are also a valuable fertilizer for the garden when thoroughly mixed with the soil. If I have enough ashes and poultry droppings, I never use any other kind of fertilizer ingredients.

Pine wood, poplar, maple or ash do not make as valuable ashes as hard wood, such as oak, hickory, dogwood or beech, due to not containing as much potash.—W. H. H., Virginia.—*Rural New Yorker.*

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Hints for the Victory Gardener

POTATOES

This is the SEVENTH of a series of articles by this author dealing with the cultivation of ordinary vegetables.

By Roger W. Smith

No vegetable is more important to the Victory gardener than the White or Irish potato. When properly grown it is high in food value and is easily stored.

The white potato was introduced to Europe from the American continent purely by accident. Someone substituted a shipload of white potatoes for a shipload of "batatas" or Haitian yams. For very good reasons we have retained both the name and the vegetable but today few Victory gardeners would be likely to mistake an Irish potato for a Haitian yam.

Potatoes succeed best in a warm, sandy or loamy soil rich in humus. Please note this demand for humus.

If your garden soil is average and has good drainage you should be able to grow potatoes provided—and only provided—a generous amount of compost humus is added to it. This addition is important. Well made compost humus is free from plant disease. It is filled with the food plants most needed to become sturdy and disease-resistant and to produce tubers of high value.

If you can secure the use of a small piece of land which has not been cultivated for several seasons and which has a deep layer of good topsoil, you can be fairly sure of avoiding soil born disease.

This new land should be broken in, preferably in the Fall, and the turf or weeds used as green manure. Early in the Spring this soil should be augmented by a very liberal amount of mature humus from a well made compost heap.

For the average family about fifteen bushels of potatoes are required each year. Five bushels of this quantity should be early, that is non-storage, potatoes. Under favorable conditions one peck of seed potatoes will plant about four hundred feet of row and furnish five bushels at harvest time. To plant twelve hundred feet of row requires a piece of ground approximately forty feet by one hundred feet.

This estimate will likely lead you to believe that potatoes require lots of room. This is only partially correct. Early sweet corn or late cabbage can be planted between rows of early potatoes. Early potatoes can be followed by some crop like late turnips.

Good seed potatoes are fairly cheap. But if you intend to plant only a few rows it is quite practicable to save the eyes from the potatoes used by your family in the early Spring. These will most likely be a fair type of storage potato. Be sure they are quite free from scab or other potato disease.

Remove the eyes with a small ball of the fleshy body of the potato attached. These eyes can be gathered daily, wrapped in waxed paper, and stored in a cool, dark place until enough have accumulated and the time has arrived to plant them.

In using these single eyes, you will find that the smaller the fleshy seed-piece the more essential it is to have congenial growing conditions. It is also necessary to plant at least double the number of eyes than would be required for pieces containing two eyes.

If you intend to make a serious planting of potatoes you will find that it pays to use only disease-free, certified seed because many diseases of potatoes are brought into the garden in and on the seed.

These seed potatoes should be cut with a clean, bright knife into chunky pieces each piece containing two eyes. It is best not to cut the seed potatoes or unwrap the stored eyes until you have prepared the place in which they are to grow.

Early potatoes like the Irish Cobbler, which matures in around 80 days, may be planted just as early in the spring as the frost is out of the ground and it has dried out enough to be worked. This is generally around the end of March in the eastern States.

You will find a very good method of planting potatoes is to open a furrow about four inches deep and ten inches wide using a hoe. A long string with a peg tied to each end and stretched tight along the surface of the ground, can be used as a guide line to help you keep the furrow straight.

The chunks of seed potato should be placed in the bottom of this furrow about one foot apart. The furrow should then be filled with humus from a well made compost heap. The row should be firmed and small stakes driven into the ground at the end of the row as markers. You can then move the guide line along and use it for the next row which should be about three feet from the first.

If spring comes early and the soil warms up soon after planting, the potato plants should appear in about two weeks. Just as soon as the rows are clearly defined you will find it a good plan to cultivate them thoroughly. If spring comes late and the frost returns it will do no harm so long as it fails to penetrate to the seed potato.

You will find that potatoes enjoy careful cultivation. They should be kept free from weeds, and as with all garden crops, they should be given close attention during the growing season.

When they reach maturity, the vines of early potatoes will show signs of dying down. At this time the soil should be well hilled up to the plants to keep the light from the tubers and to help hold the vine stalks erect. This protective ridge of earth is easily drawn up to the plants by using a hoe.

Early potatoes are usually dug as soon as the vines have died. But you can give yourself a treat by digging a few extra early ones while the vines are still partly green.

Early potatoes are grown for immediate use. It is usually necessary to dig them during the heat of summer. For this reason they are best stored in a cool, dry, airy place until freezing weather when they may be moved to the protection of a dry cellar. Above all they should not be exposed to sunlight or dampness.

If you have provided plenty of rich humus, the moisture has been sufficient, and the seed used free from disease, you should have little trouble with such potato diseases as scab and blight.

Strong, healthy vines are usually sufficiently tolerant to plant diseases to produce a good crop even under adverse conditions. However, insect pests sometimes do considerable leaf damage and thereby cause a reduction in the crop.

The worst of these insects are those of the potato-beetle type. It is unwise to use either lime or woodashes on land planted to potatoes, so the simplest remedy is to beat the beetles off as soon as they appear. This can be done with a handful of twiggy material. A wide, shallow pan containing a little oily water should be placed underneath the vine in such a position that the beetles will fall into it. A good time to do this is during cloudy weather when the beetles are most sluggish.

The procedure for growing late potatoes for storage, such as Green Mountain or Katahden, both of which mature in about 140 days, is about the same as that used for early potatoes except that late potatoes are not usually planted until late in May.

Just as with early potatoes, you will find it profitable to cultivate late potatoes carefully. Neglect can cause a greater reduction in the crop than any single type of insect pest. Late potatoes should be hilled with earth the same as early potatoes. Then, when the fall frosts have completely killed the vines, you will have the satisfaction of digging a worthwhile crop.

After digging potatoes you will face the problem of storing them. Since the successful storage of home grown foodstuffs is a vital and necessary duty, this matter should be attended to with the utmost care.

Potatoes will not stand freezing. They are best stored at from 36 to 40 degrees Fahrenheit. If kept at a lower temperature they develop undesirable sweetness. They should be kept in the dark to prevent them from becoming green and almost inedible. The relative humidity should be between 90 and 95 per cent to prevent drying and shrivelling. It is best not to wash potatoes

before placing them in storage but to air them for an hour or so in a shady place.

Summed up, this means that they should be stored in a cool, dark, slightly moist place. Obviously, while early potatoes may be stored for some time in a cement basement with a furnace, the same place is usually much too dry and warm for late potatoes.

Unless you plan to build a small, permanent storage cellar you will find that the simplest method of storing a few bushels of late potatoes is to make two or three conical piles. It is best to make several small piles rather than one large one because when a pile is opened during winter conditions it is usually impossible to seal it again properly. The entire contents has to be removed.

In a well-drained spot dig out a circular place seven or eight inches deep and as large as may be required. Fill this space with straw, dry leaves, or similar litter. Before there is danger of freezing the potatoes, make a conical pile of them using the litter for the foundation. At this time all immature, diseased, or damaged potatoes should be set aside.

The conical pile should then be covered with a foot thick layer of straw, dry grass, or litter. A foot thick layer of earth should be applied over this and smoothed evenly with the back of a shovel. The thickness of the covering of the pile depends upon the severity of the winter in your locality. It is better to err on the side of too much than too little. If you believe it will be necessary, another layer of straw and another layer of earth may be added. In any event, it is advisable to add an outside layer of heavy brush or corn stalks during exceptionally cold weather.

The ventilation of stored material is important. This is most easily arranged in the conical pile by so building the pile that the straw covering protrudes through the earth covering at the peak of the pile. Enough air will escape through this peak of straw to ventilate the pile. The entrance of rainwater can be prevented by covering the bunch of straw with an inverted pan or box held in place by cord.

Because stored potatoes require a high degree of humidity those improperly stored in cellars in large quantities are sometimes subject to rot. One method of preventing the spread of this trouble is to move the spoiling potatoes to a dry floor and dust them with finely powdered limestone.

They should be turned several times until they are evenly coated with lime dust. They should then be sorted and the damaged ones discarded. The others may be returned to their place of storage. The covering of lime dust is sufficient to prevent a return of the condition which was favorable to the spread of the parasitic fungus growth which caused the rotting.

And with the final care of the stored potatoes you review what you have done during the season. You have many bushels of healthy potatoes stored away for the use of your family during the long winter months. You started with the use of a bit of idle land, a few packages of potato eyes collected before meals, or a peck or two of seed potatoes purchased with frugality. With these you have succeeded in producing essential foodstuff for your family, a not inconsiderable feat in these days when wholesome food is greatly in demand.

You will have made little discoveries along the way. You will have noticed the very beneficial effect that a liberal supply of compost humus has upon plant growth. You have yet to learn how much superior the potatoes are that you have grown when compared with those produced commercially.

At harvest time, save all the small walnut-sized, tubers. Wash them thoroughly and boil them in their skins. Notice how superior they are in flavor as compared with store supplied potatoes. You can be sure that those you have stored away and which were also grown with the aid of compost humus will also be of superior quality.

You have discovered that potato vines produce modest flowers which produce seed, often called "potato balls." Perhaps you have become interested enough to have decided to secure a few of these seeds and plant them next year. They are usually much crossed and produce many varieties of potatoes.

Above all, you have the quiet satisfaction of having produced something substantial for the use of your family. You have performed an important and patriotic duty.

The Biological Role of the Earthworm

By Dr. Ehrenfreid E. Pfeiffer

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HUMUS is the basis of the fertility of the soil. But not all substances called humus are "humus." There is only one kind which provides the most valuable substances and a desirable soil structure. The scientist calls it the neutral colloidal humus, neutral with regard to its reaction as compared with an acid or alkaline state. All cultivated plants thrive best in a neutral soil, while with increasing acidity more and more cultivated plants cease to grow. They dislike alkaline soil just as much.

The term colloidal signifies a state of matter solid and liquid which exists in all living organisms. Only in this state can the "living matter" be maintained. The presence of neutral colloidal humus therefore is a necessity in order to maintain the soil life as well as the proper plant growth. In a soil rich in this kind of humus, plant roots develop the finer hair roots which contribute so much to the intake or nourishment. The humus is produced by a fermentation process which takes place in a living soil. It is composed of decaying plant matter, leaves, dead roots, stems, straw, and also of manure, compost and of the bodies of microbes, bacteria and algae living in the soil. One animal is devoted exclusively to the humus production —the earthworm. Charles Darwin, in his book about the earthworm, said: "Without the earthworm, no tillable soil." This little innocent and rather helpless-looking animal is our best soil friend. Due to its activity we have a tillable, rich soil. Otherwise, the earth would be covered with rocks, stones, silt and all kinds of diluvial and alluvial deposits, but very little higher plant life could develop. The study of the earthworm is fascinating because of its value to farming and gardening. The presence of the earthworm and the quantity thereof indicate the quality and state of cultivation of a given soil. Its absence indicates serious trouble, an "unhealthy" state of life, less productivity or even a tendency towards a sterile and unfertile soil.

It is clear that the earthworm does not belong in a hotbed, a cold frame or a flower pot where it may do occasional damage by uprooting or drawing down small plants or seedlings, but otherwise no harm comes from the earthworm's activities. Should it happen that in a garden earthworms attack live roots or seedlings, then something is utterly wrong with the state of affairs in this garden. A deficiency in humus, a one-sided fertilizing with excessive minerals or lime, fresh manure in bad shape (putrefaction) may disturb the proper living conditions for this little friend of ours.

The earthworm is a specialist, and as such needs proper attention. Of the different varieties and species, two groups are of particular interest to the gardener. Type number one is a long bluish, rather thin type, which transforms all organic matter in the soil into humus, and particularly so if the soil has already undergone certain changes. Type number two is rather short, thick, reddish and is the manure and compost worm. Its main duty is the transformation of fresh manure and compost and other matter that is just in the first state of rotting. Type number one would not touch, for instance, fresh manure, but makes the best possible use of decomposed manure and compost.

How does it work out, this transformation of organic matter into neutral colloidal humus? The worm eats earth and small parts of leaves, straw and all kinds of organic

particles in the soil. Both earth and organic matter are mixed in the mouth and intestines and digested with the help of an intestinal juice rich in hormones and digestive ferments. One peculiarity speeds up this process, namely, "saliva" glandular juice with an organic calcium compound. The final result of the rather complicated digestive system, full of wisdom, is the neutral colloidal humus. The earthworm excrements, the so-called castings, are the richest and purest humus matter in the world. Analyses have shown that they contain more than ten times as much of valuable plant nutriments such as nitrogen, phosphates, calcium, etc., as the surrounding soil. A Polish scientist, Niklewski, has devoted much study to the humus contained in the earthworm castings and has stated their richness in humus colloids and their importance for the development of fine hair roots.

As to the efficiency of humus production, we look upon it as a sample of the highest possible grade of perfection. In a soil in good healthy condition, for instance, a pasture rich in clover, or an alfalfa or clover field at its best, as many as 300 pounds of earthworms to the acre have been counted, producing about 30,000 to 40,000 pounds of humus an acre per year. No other means of fertilizing or manuring would ever be able to maintain and improve the fertility of a soil to the same degree as the earthworm.

If we figure out that one acre of topsoil to a depth of seven inches weighs about three million pounds, a proper earthworm population digests about 1 per cent of this soil per year. Besides the humus production in castings there is the forming of little channels. which increase the porosity and aeration of the soil. This helps other kinds of soil life, stimulating, for instance, about 600 pounds of bacteria per acre a year to contribute their share. Experiments have shown that through earthworm activity the volume of a soil is increased by one-third, which gives an idea as to the loosening up or crumbling of the soil.

Furthermore, the little fellow penetrates downward to about five or six feet, transporting lime, minerals and salts gradually to the upper layers. Many substances previously washed out are in this way brought back to the topsoil. This may explain why soils rich in worms have a considerable increase in calcium content.

Under these circumstances, nobody will doubt that the proper use of earthworms is one of the most important questions of any biological farming or gardening method. But how can we preserve or increase these helpers of the soil?

Unfortunately the life cycle of the earthworm is rather limited. The little fellow is highly specialized. A type number one worm will not propagate in a fresh manure heap; neither will it migrate and accustom itself to a clay soil from a sandy soil or vice versa. It is locally soilbound. The type number two, the manure earthworm, will not multiply in soil except if sufficient manure or compost is present. It is in our interest, therefore, to assist the worm's life. Proper tillage and aeration of the soil, together with the right moisture conditions, facilitate the reproduction. If well-rotted manure or compost is added to the soil, you will see the little fellows multiply as long as they find moisture and warmth. In the fall before the frost and during an extended drought they migrate to deeper quarters and remain inert. But before that time, if well provided with rotten manure and compost, they will propagate and at least the egg capsules may remain for future activity. The crop rotation also influences the development of the earthworm. Old pastures and fields with leguminous plants like clover, alfalfa, beans, peas, soybeans or lupins are usually rich in earthworm life; while a crop rotation with a few of the above-mentioned plants and with successive crops of grain gradually depletes the humus and therefore also the soil life. Too great an acidity or alkalinity has a similar effect.

The manure-compost earthworm develops in the manure or compost if the heap is in direct touch with the soil and covered with earth, and in the case of compost heaps if earth is interlayed with the compost. As long as proper moisture warmth conditions are maintained this type of worm will propagate and gradually transform all manure and compost material into humus. The limits of the worm's lives depend upon drought, low and high temperatures. Heaps which heat up too much, above 125° F., are destructive to the worm, as well as frozen heaps and soil. While the Southern climate in general is less favorable to the "earth" type of

worm because of its periods of drought and heat, it is very helpful to the compost type as long as there is enough moisture, and this can be maintained by watering the manure or compost heap.

The earthworm population of a compost or manure pile can be increased by adding earthworm egg capsules. The late Doctor G. S. Oliver, of Los Angeles, California, and his successors have developed a process which is very successful for breeding worms. If proper conditions in a heap are maintained the worms will propagate by the thousands. The capsules are produced by a peculiar process. The worm hatches the eggs first in the mouth, then produces by means of perspiration a kind of membrane around the head part of the body like a hose. Into this hose about six to twelve eggs are placed by gradually backing out of it and sealing it up. While worms cannot be transplanted from one kind of soil or compost into another, it is very easy to ship the egg capsules and insert them wherever they are needed. Areas in which there is an abundance of roots and of certain plants and trees are preferable as breeding grounds of both types of earthworms. Particularly oak, birch and locust trees, elder and alder shrubs belong to this group. Of annual and biennial plants the already mentioned leguminous family, as well as chicory, onions and valeriana, attract the worms. The addition of leaves or root earth from these plants to a compost heap will greatly reinforce the biological activity. The author has made interesting experiments in order to study the growth and living conditions of worms which squeezed out from experimental boxes and disappeared. When valerian blossom juice in a high dilution was sprayed onto the surface of the earth no more trouble was encountered due to the worms escaping. As a matter of fact, the worms not only propagated more abundantly, but they also migrated towards those areas sprayed with valerian extract. The Bio-Dynamic treatment of compost and manure reckons with all these peculiarities of the earthworm and stimulates its growth and reproduction.

It remains to say a few words about intensive application of insect sprays containing lead, arsenic or copper. These are biologically poisonous and counteract the development of earthworms. In vineyards or orchards treated intensively for many years with these sprays no earthworms can be found.

Midsummer in the Vegetable Garden

By Roger W. Smith

THE heat of July too often brings the activities in the vegetable garden to a close. It is the one month that will show whether or not you are a wise gardener. July is the dividing line between two parts of an active gardening season, each consisting of 120 days approximately, April-May-June and July-August-September.

Some time in late March you prepared for your early Spring crops. In July, or a little before, you make preparations for your late crops. The wise gardener keeps these two periods clear in his mind and uses them to advantage. The unwise gardener, on the other hand, takes it easy during midsummer, harvests what there is, and reaps only half of what he might have harvested. For the late crops form the bulk of the garden vegetables grown for storage and canning; they are by far the most important part of the garden harvest.

Considering this matter reflectively while you rest a moment in the cool shade of a tree not too far from your garden, you realize that the April-May-June period begins with cool weather and ends with warmth, while the July-August-September period begins in heat and ends in relatively cool weather. Here you notice a condition which should be valuable.

You look your garden over. There are many gaps in the

rows. Much of the early planted vegetables have already been harvested. With some crops, such as snap beans, it is possible to make new plantings of the same vegetable. But with others it is much the best plan to select a substitute. Endive, for example, does well as a late crop and is an agreeable substitute for lettuce. Spring radishes have already given way for summer, white icicle types; these should in turn be replaced by fall maturing Black Spanish radishes.

You will find that there are many crops of great value for late planting, crops which improve in growth as the weather cools. Late broccoli (green-sprouting Calabrese), late cabbage (Danish Roundhead) and a few late red cabbages (grown extensively for pickling) are best planted so that they will mature their heads about the time the first fall frosts arrive.

July-August is the best time to plant Chinese Cabbage, and the finest of the crumpled-leaf Savoys are usually set out about this time. Kale, cauliflower, dandelion, kohlrabi, turnips, and many other very worthwhile crops may be set out to occupy space left vacant by earlier crops. These late types were developed especially for fall growth.

But you will find that in this matter of using the same garden soil twice in the same season several matters must be taken care of. In the first place, the soil must be replenished so far as natural humus is concerned to prevent its exhaustion; in the second place, precautions must be taken to prevent a preceding crop from passing on to a later crop the plant disease or insects which attacked it. Succession plantings of snap beans, for example, should not be made on the same ground.

For the same reason, avoid setting out late cabbage, cauliflower, broccoli, etc. on ground which had been occupied by early crops of a similar nature. You will find it best, also, to try to arrange to set out late leaf crops to follow early root crops—radishes, beets, carrots, etc.—and to plant root crops to follow very early leaf crops.

Late leaf crops do better in soil which has been used for root crops because the deep seeking roots of the root crops bring the soil into a more congenial condition for the shallow roots of the leaf plants. Also each type of crop tends to replace some of the food material required by the other.

The heat of July brings with it a host of pleasant tasks: the hanging of a waterfilled crock in a breezy, shady place; the gathering of such small fruits as currants and gooseberries, the arranging and summer pruning of a few grape vines arranged along a fence. The making of a seedbed for the production of late plants is often a joy in itself compared to the work of producing plants for setting out in early spring.

Unlike the spring seed bed which had to be arranged indoors or in a cold frame, the summer seed bed may be planted in the open garden. But the seed should be as carefully planted as in the spring time and should be covered with a layer of wet sacking or similar material. This covering should be removed just as soon as germination becomes apparent and partial shade should be supplied the seedlings during very hot weather by placing slats or brush over the bed.

You will find that the setting out of transplants of late cabbage, etc. in summer time requires a little more care than a similar task performed in early spring. Heat sunlight and drying out have to be guarded against instead of lack of light and cold. Water should be used unsparingly. The roots of the transplants should be kept shaded and damp while the plants are being moved. Some method of protecting them after setting them out should be arranged. Inverted boxes, baskets, cartons, etc. will serve this purpose.

Yet using every precaution you will find it advisable to do this work in the cool of the evening, even though the mosquitoes do bother you most at this time.

Summer succession plantings of snap beans, carrots, etc. planted in drills in the open garden, should be very carefully firmed to insure their germination during dry weather. Often it pays to cover the drills, after the seed has been properly watered and firmed, with planks, boards, or other covering. Upon the first signs of germination these things should be promptly removed.

When the heat and drought of midsummer comes around you might get to wondering how garden vegetables consisting so largely of water manage to grow and survive. It has been said that a garden vegetable requires an inch of rainwater every ten days. This is probably so. If rain fails to come you might find it advisable to resort to artificial watering. This is best done by placing the hose on the ground and giving the area around it a thorough soaking during the evening.

However, if you have been generous in your application of compost humus to the soil of your garden, the water absorbed and retained by this material during rains will usually be sufficient to adequately supply the urgent demands of the plants during dry spells.

Sometimes during the summer you might wish to cause increased growth in some particular crop. The beets or the late broccoli might need a little encouragement. Improved growth and health in garden plants can often be brought about by the use of summer mulch. A three inch deep layer of compost humus applied along the rows will usually cause the plants to pick up rapidly.

Of course, straw, sawdust, grass clippings, leaves, used as a mulch will help, but compost humus applied in this way serves a double purpose. It protects the shallow-rooted plants from wilting and drying out, at the same time water passing through it picks up soluble plant food which it delivers to the rootlets.

When straw or other similar material is used as a summer mulch, it is a good plan to supply this extra nourishment needed to produce the rapid growth generally necessary to develop crisp, fresh vegetables by using a mixture of compost humus and water. This mixture is easily made by placing a quantity of sifted compost humus in a large barrel and covering it with water. After twenty-four hours the liquid may be drawn off and applied to the plants most in need of it. It may be used without danger of burning roots and other damage often associated with the use of solutions made from raw cow manure or artificial fertilizers. Solutions made from raw cow manure have been shown to have a tendency to produce a disease known as scab in beets and potatoes and they have been found to contain little plant food value in an available condition until the liquid had remained in the ground for several days.

Midsummer is often a period of shortage of rainwater but you have the bright prospect that as cool weather approaches this condition will become less acute. At this season, the more you go into the matter of what should be done the more things of interest you will find.

Weeding has to be done, of course, and cultivation. There are opportunities to replant a considerable part of your garden to late crops. If you have a fairly large place, this is important. For example, the large area planted to early potatoes, which will be harvested in July, could be replanted to spinach and turnips.

In the summer weather you will find additional joy in filling some sort of receptable to serve as a drinking place for the birds. You enjoy watching them use it. You enjoy, as you stand in the shade under the tree, watching your dog dig a deep hole in a cool place under a bush to escape the heat. But above all, after the late plantings have been made and everything prepared for the fall crop, you appreciate a deep sense of satisfaction at having done your best and at being well prepared for the coming of Fall.

Human Life Depends on Bacteria

Were it not for the bacteria in the soil, plant would die and mankind also as a result, says Dr. Theodore D. Beckwith. All plant life derives its food from bacterial activity.

"The mind of man has difficulty in comprehending the number of microbes ordinarily found in soil and which are so fundamental to man," he points out. "A usual population of one ounce of top soil in a cultivated field is more than 150,000,000 bacteria. In an acre are 1,500 tons in the top foot of soil.

"Besides the bacterial population, which is too great to be computed, are other varieties of microbes occurring in smaller numbers, the population still high but decreasing for five or ten feet below surface.

"We should recognize the fact that the micro-organism is more likely to be the friend than the enemy of man."

My Grandfather's Earthworm Farm

A fact story by Thomas J. Barrett
P. O. Box 488, Roscoe, California

The story of a self-contained farm of 160 acres, farmed and maintained in undiminishing, but increasing, fertility over a period of more than sixty years, through the utilization of earthworms. This fact story was related to the author by Dr. George Sheffield Oliver, pioneer earthworm culturist of California.

This is a chapter from a forthcoming book on the Earthworm

WHEN, as a small boy, I went to live with my grandfather, George Sheffield, in Huron County, Ohio, near Norwalk, I found him living on a model farm of 160 acres, which he had farmed continuously for more than sixty years. He was a man who loved the soil and took pride in every detail of his farm. As a man, I remember him as a tall, striking figure, of the type of Edward Markham. In fact, in later years when I came across a picture of the poet Markham, I was struck by the close resemblance of the two men—their features were almost identical and they could have been easily taken for twins. One of my most pleasant remembrances of the period of several years which I spent on this farm was the daily horseback rides I took with my grandfather. After all these years, I can still see him, at the age of 75, swinging into the saddle with the ease and grace of the practiced horseman, with the facility of a man in his prime. At that age he still took delight in riding the young three-year-olds. He lived to the ripe old age of 91.

Originally, this farm holding had been 1,800 acres, but had been sold off to tenants in 40-acre tracts until there remained only the farmstead of 160 acres. It had been the practice of my grandfather to select young, single men as farm help. As these men reached maturity and married and wanted to set up a home of their own, my grandfather would set them up on a forty-acre tract, assist them in getting started and accept a payment contract over a period of 40 years. Thus his close neighbors were men who loved the soil, like himself, and who could cooperate in all community work. My grandfather often remarked that he was making more net profit on his 160 acres than he ever made on the original 1800 acres, due to his lifetime experience and the improved methods of farm technique and the intensive utilization of the earthworm.

The homestead was located at the center of the farm, surrounded by four acres of orchard and garden, which furnished an abundance of fruits and vegetables the year round. Root cellars, vegetable banks, canned and dried fruits and vegetables, provided for the winter months. The house and orchard was backed by forty acres of heavily timbered land—maple, hickory, black walnut, burr oak and many other trees native to Ohio. Incidentally, the farm was fenced with black walnut rails—

beatiful timber that would be almost priceless at this time. My grandfather called this timbered tract his park and it was, indeed, a wonderful park, abounding in small game and bird life to delight the soul of a small boy with his first gun. The park was well-watered with living springs and a quite generous-sized creek ran through the place. large enough to furnish all the fish the family needed. I was designated as the official fish-catcher for the family, a task which I dearly loved.

To get a picture of the lay-out of the farm is important in understanding its efficient operation without waste of time and energy. It was divided into four tracts of 40 acres each. The homestead, with orchard, garden and park occupied one 40. At the center of the 160 acres was located the great barnyard of about 2 acres, with broad swinging gates in each of the four sides, with lanes leading into each of the 40-acre tracts. Thus the stock could be herded into any part of the farm, simply by opening the proper gate and driving them through the particular lane into the section that was to be pastured. Located in the four corners of the barnyard were the strawstacks—alternating, wheat stack, oat stack, wheat stack, oat stack. These stacks occupied permanent raised platforms, about six feet above the ground, resting on sturdy walnut posts and built of small logs, or poles, cut from the woods. Thus, the stock had good shelter in the winter under these platforms, feeding on the straw overhead through the cracks between the logs. Plenty of straw was always thrown down and distributed for bedding. My grandfather claimed that the wheat straw and oat straw each added valuable elements to the fertility of his compost, so he alternated the straw-stacks so that the two would be evenly mixed.

In the center of the barnyard was the compost pit, which, in the light of modern technical knowledge, I now know to have been the most perfect and scientific fertilizer production unit I have ever known. This pit was 50 feet wide and 100 feet long and had been excavated to a depth of two feet. At each end, evenly spaced from side to side and about 20 feet from the end, was deeply anchored a heavy log post, probably 12 to 15 feet high, with an overhead cable anchored to each post and running to the barn. On these cables were large traveling baskets. Thus, each morning the manure from the great barn was transported in these baskets to the compost pit and evenly spread in a uniform layer, by means of the post in each end of the pit the manure being dumped at the most convenient point for proper handling. By means of these automatic dump baskets and overhead trolley, it was possible to quickly clear the barn of the night droppings and deposit the material in the compost pit without any loss of the valuable elements of the fresh manure. This is a most important point in the utilization of the earthworm for general farm use.

Just outside the barnyard ran the creek, which found its source in a big spring in the "park." From this creek, an abundance of clear, clean water was piped by gravity into the watering troughs for the stock in the barn and yard. Also a flume with a controlled intake led to the compost pit, so that when necessary the compost could be flooded in a few minutes by the gravity flow. The homestead occupied land on a higher level than the barnyard, so that drainage was always away from the house and no chance for pollution from the teeming life of the barnyard.

To one side of the barnyard and at a higher level than the floor of the yard was located the ice pond. This pond was so arranged that it could be filled from a flume leading by gravity from the creek to one end, while at the lower end a spillway was provided so that the pond could be drained. At the proper season, the ice pond would be filled to the proper level and when the ice formed to the proper thickness the annual harvest of ice was cut and stored in the ice house, to provide an abundance of ice for all purposes the year round. The bottom of this pond was formed of a fine-textured red clay. Each spring the pond was drained and with teams and scrapers many tons of this clay was scraped out and diked around the borders of the pond, to weather for use on the compost heap.

And now enters the earthworm. For more than sixty years my grandfather had farmed this 160 acres without a single crop failure. He was known far and wide for the unexcelled excellence of his corn and other grain and a large part of his surplus grain was disposed of at top or fancy prices for seed purposes. The farm was a combination of general farming and stock

raising. My grandfather's hobby, for pleasure and profit, was the breeding and training of matched Hamiltonian teams and saddle horses. He maintained a herd of about fifty horses, including stud, brood mares and colts in all stages of development. In addition to horses, he had cattle, sheep, hogs and a variety of fowl, including a flock of about five hundred chickens which had the run of the barn yard, with a flock of ducks. Usually about three hundred head of stock was wintered. The hired help consisted of three to four men, according to the season, three men being kept the year round, with additional help at certain rush seasons. This establishment was maintained in plenty and prosperity and my grandfather attributed his unvarying success to his utilization of the earthworm in maintaining and rebuilding the fertility of the soil in an unbroken cycle. The heart of the farming technique was the compost pit.

As previously mentioned, the pit was 50 by 100 feet, excavated to a depth of two feet especially to provide a great breeding bed for earthworms. Literally millions of earthworms inhabited this pit. Part of the daily routine of the farm work was the building of the compost heap. Each morning the barn was cleared of the droppings for the previous 24 hours, being transported in the dump baskets on the overhead trolley and dumped on the compost heap, there it was evenly spread over the surface. The flock of chickens everlastingly scratched and worked in the barnyard, assisted by the ducks, gleaning every bit of undigested grain that found its way into the manure and, incidentally adding about twenty tons of droppings per year to the material that eventually found its way into the compost heap. The cattle and sheep used around the four straw stacks and bedded under the shelter of the stacks, adding their droppings to the surface and treading it into the bedding material. From time to time, the entire barnyard was raked and scraped, the combined manure and litter being borrowed to the compost heap and distributed in an even layer on the surface. As the compost was built up to a depth of twelve to fourteen inches, several tons of red clay which had been scraped from the ice pond was hauled in and distributed in an even layer over the entire surface of the compost. Thus, the variety of animal manures from horses, cattle, sheep, hogs and fowl, mixed with the bedding material of wheat straw and oat straw, alternated in the compost heap in layers of twelve to fourteen inches thick, with layers of red, fine-textured clay, rich in parent mineral substance. Meantime, beneath the surface the earthworms multiplied in untold millions, gorging ceaselessly upon the manures and decomposing vegetable material, as well as combining with this diet the mineral clay soil, and depositing their excreta in the form of castings—a completely broken down, deodorized, soil, rich in all the elements for plant life. From time to time, as careful inspection by my grandfather would determine, the compost would be watered from the flume leading from the creek, thus providing the necessary moisture to enable the earthworms to work to the greatest advantage in their life-work of converting compost to humus.

By the time the spring thaw arrived, the season of the annual plowing, the earthworms had completed their work in the lower layers of the compost heap. The top layer of the heap would be stripped back, revealing the perfect work of the worms. What had originally been a damp, ill-smelling mixture of manure, urine, and litter, was now a rich, dark crumbly vegetable and animal mould earth, with the odor of fresh-turned earth. This material was not handled with forks, but with shovels, for there were no dense, burned cakes of half-decomposed manure. My grandfather would take a handful of the material and smell of it, before pronouncing it ready for the fields. No material that was not completely broken down was allowed to go into the fields and the "small test" was a sure way of judging material. When perfect transformation had taken place, all odor of manure had disappeared and the material had the clean smell of new earth. At this time of year, at the beginning of the spring plowing, the compost heap was almost a solid mass of earthworms and every shovelful of material would contain scores of worms and, as I now know from years of experiment and study, every foot of this material contained hundreds and hundreds of earthworm capsules, which would within a few days of burial in the fields hatch out from four to twenty earthworms each, to immediately begin their life-work of digesting the organic material of the

soil, mixing it with much earth in the process, and depositing it in and on the surface of the earth in the form of castings—a finely divided, homogenized soil, rich in the stored and available elements of plant food in water-soluble form.

When the spring plowing began, the following method of preparing the soil was followed: Several teams, usually three or four, were used with the plows, while two or three farm wagons with deep beds and high sideboards, were used in hauling the rich, crumbly end-product of the earthworms from the compost pit to the fields. The wagons worked ahead of the plows, the material being spread generously on the surface with shovels and immediately plowed under. Seldom was any material exposed on the surface more than a few minutes ahead of the plows, for part of the technique followed was to plow the live earthworms under, with their capsules, so that all surviving earthworms could continue their valuable work in the soil, as well as the burying of the capsules immediately so that they would escape the voracious marauding crows which swarmed in great flocks to the feast of worms and capsules so thoughtfully spread for them. At this time, to my great delight, I was appointed official crow hunter and armed with a light shotgun I industriously banged away at the crows to my hearts' content, killing some of them and keeping hundreds of them at a distance until the plows could turn the earth and bury the worms and capsules safely from the birds and the sun. In this manner, I estimate that from 15 to 20 tons of this highly potent fertilizer material was annually plowed into the fields in preparation for the crops to follow. On account of this technique, not only was the earth continually occupied by a very numerous worm population the year round, but annually a vast new "seeding" with live earthworms and capsules was planted to renew and replenish the earth.

More than forty years after my experience on my "Grandfather's Earthworm Farm," studies of the earthworms in the soil of Ohio were made by the Ohio State University and on the Ohio State University Farm they reported earthworms in plots of soil covered by bluegrass in numbers of one million or more to the acre. From my experience in more than forty years of study and experimentation with earthworms in the soil and in growing plants, I am sure that the earthworm population of my grandfather's farm far exceeded one million to the acre.

In the annual distribution of the fertilizer, my grandfather never completely stripped the compost pit. One year he would begin the hauling at one end of the pit, stripping back the top layers of material which had not been broken down, and leaving a generous portion of the other end of the pit undisturbed as a breeding and culture ground for the remaining earthworms. After the hauling of the fertilizer was completed, the surplus top material was evenly distributed over the entire pit for the "mother substance" and the new compost heap was thus begun. The following year, the hauling would begin at the other end of the pit. Thus, by alternating, there was always a large undisturbed breeding ground to conserve the earthworms for their important work. In this warm, highly favorable environment, they multiplied with maximum rapidity. In my experiments in later years, I determined that in a favorable environment, with abundance of food material to work on, certain breeds of earthworms will work ceaselessly in concentrations of more than 50,000 to the cubic yard and that 50,000 earthworms thus working will completely break down one cubic yard of material per month. Thus, in nature we have a constructive force which creates humus with amazing rapidity when given the opportunity, and under proper control furnishes a method of completely utilizing every possible end-product of biological activity through the very simple process of composting with earthworms. The excreting of humus is just one important function of the earthworm and working directly in the soil as the numerous earthworm colonies are established through the proper technique as mentioned above, the aeration of the soil to a depth of several feet, the constant conversion of parent material in the deep layers of the subsoil and translocation through the castings to the surface layers are among the important things that earthworms do to the soil.

Going back to my grandfather's farm, his regular rotation of crops was corn, wheat, timothy and clover hay, in a three-year cycle. Once every year one forty-acre field was planted to timothy and clover. A crop of hay was harvested and stored for the winter, the field was used for

grazing and finally a rich crop was turned under for green manure. In this manner, each year one forty-acre tract was left undisturbed by the plow for a number of months, allowing the earthworm population to work and multiply to the maximum, while converting the organic material into the finest form of humus. When the clover fields were plowed under an almost unbelievable number of earthworms were exposed as the sod was turned.

One fact I failed to mention before was that this land was not what is usually considered the finest to begin with. It was a thin top soil—only six to eight inches in depth over much of the farm, underlaid by limestone. On account of the shallow depth of the soil, no deep subsoil plowing was possible. I well remember how the plows would scoot along on top of the almost surface limestone layer. However, the vast earthworm population penetrated deeply into the subsoil and constantly brought up the parent material to help replenish and rebuild the surface soil, which made up for the lack of deep soil. My grandfather often remarked that in all his sixty years of farming under this method he had never had a crop failure. His corn was the finest in all the surrounding country and was eagerly sought for seed. He also originated a sweet corn which was very highly esteemed throughout that section and was known at that time as "Sheffield corn." This corn was of a delicious flavor. The ears were very uniform and evenly filled to the very end with exactly eight rows of grain. I remember that the cob of this special Sheffield corn was hardly larger than a carpenter's lead pencil. My grandfather never sold this corn, but reserved it to give to friends who came from far and wide for the prized seed and even wrote to him for seed from distant points.

Looking back to my experience on my grandfather's farm through the long vista of the years, with my own experience, as well as the experience of a host of others to draw from, I am struck by the reflection that here was a simple farmer, working independently without any specialized knowledge of earthworms to begin with, long before Charles Darwin wrote his famous book on "The Formation of Vegetable Mould Through the Action of Earthworms," and yet in an intensely practical way utilizing all that Darwin later revealed in his great book, with the exception that Darwin never suggested "harnessing the earthworm" for intensive human use, but only revealed the importance of the work of the earthworm in nature, both past and present.

Before ending this narrative of my grandfather's earthworm farm, I must mention the orchard and garden and fence rows. The fence rows throughout the farm were planted to a great variety of fruit trees, which were allowed to develop from seedlings. Particularly do I remember the cherry trees, some of them fifty feet high, each tree bearing a different kind of fruit. In the four acres of orchard and garden surrounding the house was a great variety of fruit, furnishing the greatest abundance for the family, as well as for many of the neighbors in season. In those days the fruit was not sold. Particularly do I remember an often repeated remark of my grandfather regarding the care of a tree, especially fruit trees. He said, "never disturb the soil under a tree. The earthworm is the best plow for taking care of a tree and I don't want them disturbed." The vegetable garden was fine, kept wonderfully enriched from the compost pit, and the soil being literally alive with earthworms. A profusion of flowers, both potted and otherwise, as well as a wealth of shrubbery, beautified the place. For especially choice flowers, we would use a very fine mixture of finely broken up soil and material from the compost pit.

In this example of my grandfather's earthworm farm, we have the technique of utilizing the earthworm in general farming operations, either on a large scale or on a small scale. From my experience as a small boy growing up on this farm with much friendly and loving instruction from my grandfather on the subject of earthworms, and in my own work covering a period of more than forty years, I am fully convinced that the eventual salvation of the soil of our country will include the harnessing of the earthworm as one of the major measures. And from my experience, I know that the soil can be made to produce several times as much food as the present average, through the proper harnessing and utilization of the earthworm under control.

Notes On Compost Heaps

DON'T forget to keep the heap at a consistency of a wet sponge. Don't get it too wet, nor let it dry out. During spells of wet weather no watering is necessary.

Be sure to make the holes in the top of the heap to permit air to penetrate to all parts of the heap.

Don't make the heap on a concrete base. You will get best results on an earth foundation especially if you remove about six inches or so of the ground layer of sod and soil. Bacteria and earthworms in the soil will help the action of the heap. Use the earth so removed in the heap.

Don't permit weeds to grow on the heaps. Be sure to weed the heaps from time to time.

A straw mulch on top of the heap helps somewhat and also prevents the top of the heap from drying out.

When laying out heaps figure out a neat arrangement, with ease of accessibility in mind and nearness to water supply. Avoid a haphazard arrangement.

Figure out the best size for your needs. For a small garden a heap should not be more than 6 feet wide and 5 feet high. You can make it almost any length. Ten or twelve feet is the average length of the small feet. Large heaps can be made 12 feet wide and almost any convenient length; usually 24 feet long, more or less.

For best results the entire heap must be turned over after three weeks. It should be turned again five weeks later. Four weeks after the second turn it is ready for application to the land. In big operations, due to help shortages, no doubt it will be impossible to get the labor to do the turning. In that case the heap will take a year or more to be ready for use.

In making the heap, the green matter is laid down first, about 6 inches. It is best if such green matter is accumulated in advance in heaps and allowed to wither. Then comes about two inches of manure. In small heaps, for small gardens, where manure is not available, use kitchen meat scraps and animal matter, bone meal which may be purchased, and other organic materials such as tankage, purchased meat scraps, etc. Sprinkle lime on the manure, then apply a thin layer of earth. Then start the process all over again.

Wood ashes is better than lime. If you have a cheap supply of wood available, you may be interested in heating your home with wood, so as to get the wood ashes for your heaps. If so send 10c for Bulletin 463 to the Connecticut Agr. Exp. Station at New Haven, Conn. This bulletin is called "A wood-burning conversion unit for household furnaces," and describes how to easily convert a coal or oil burning furnace to wood.

If you have no manure available for composting and your garden is small, purchase some sheep manure in the hardware stores. By composting it and adding plenty of green material and some earth, you will increase your volume of manure at least three-fold.

Earthworm Idyll

It was one of the first warm days of spring. A brown leaf on the ground moved slightly and then was pushed aside as an inch of worm thrust itself out. It remained thus, drinking in the balmy air and the beauties of awakening nature.

After a time, chancing to look about, it observed another worm also bent on reconnoitering. Gazing at it raptly, the first worm exclaimed:

"Ah, what soul-warming sunshine! How intoxicating is the soft spring air! I feel the elixir of life pulsing in my being—kind lady, beautiful woman, will you be my mate?"

The other worm replied languidly, "Oh, quiet, you old fool —I'm your other end."—C. P. Reis, St. Paul Minnesota.

The Fault With "Combine" Wheat

By Fred Joseph Gardenhire

Former editor of Nature's Path, Back to Nature and Successful Living.

MODERN labor-saving devices may work out well in some instances– in others they may spell harm. The "combine" used in harvesting wheat seems to fall in this latter class.

Now, as most farmers know, a combine is a labor and time saver. Before its advent, wheat was harvested with a "binder" a combination mowing machine and bundling machine which required additional labor to gather the bundles into shocks like cornstalks. Then it was picked up by wagon and carted to the threshing machine where the straw was separated from the grain. It was a slow process—but scientists have begun to recognize its nutritional and yes—even its financial advantages over the modern combine.

The combine is a sort of movable mower, binder and thresher. It does all three propositions at once thus eliminating much costly in-between labor. Drawn by a powerful tractor the combine goes at the ripening wheat field—eats its way into the yellow grain—and in its wake are piles of straw and sacks of grain.

It would seem, at first glance, that much formerly-unnecessary labor was done away with and that the results would all show on the credit side of the ledger.

But this is not the case. The combine—while ingenious—while it does eliminate work—does not seem to return to the farmer the same kind of wheat—either nutritionally or with the same keeping qualities – his old-fashion harvesting method brought him.

To understand the difference in two types of grain one must understand that wheat—suitable for harvesting—is not dead ripe. It is still slightly green—in spite of its brownish appearance. If it were not—it could not be handled. When it was mowed—if it was dead ripe—the grains would shake from the stem and be lost on the ground. So, in order to handle it—mow slightly under dead ripe.

Therefore, under the old method of handling – the wheat was mowed, gathered into bundles and left in shocks in the field for awhile. This permitted the wheat grains to mature—to ripen thoroughly—even after being cut. The fact that the plant was actually separated from its roots did not stop this ripening process. Thus the starches and the oils in the wheat grain developed as they should *naturally* and were changed into substances worth far more *nutritionally* than is the partly green, undeveloped wheat that is flailed out in a combine.

Again, under the old method, a farmer could store wheat in bundles under cover during the ripening season and could thresh it out as needed when more time was available, and the seed would keep on maturing.

Another important matter which should not be overlooked is the weight of the "combine". It is questionable whether or not fields are as

productive as they should be after they have been mashed down by heavy machinery. In fact it has been conclusively proven that extremely heavy machinery compacts the earth on a farm in a dangerous way.

It seems that wheat harvested in the old way actually kept better than "combine" wheat. This is not a mere supposition but is borne out by the actual experience of at least one farmer I know here in Eastern Pennsylvania. This farmer reports that last Winter he lost a large quantity of his wheat through spoilage as a result of harvesting his crop by the combine method. Under the old system he had very little or no spoilage at all. It would be interesting to know what the experiences of other readers have been—in other localities—regarding the spoilage of wheat which has been harvested by the "combine" method.

With Sir Albert Howard

March 4, 1943.

Sir Albert Howard
Haversham
Milnthorpe, Westmoreland,
England.

What would you consider as the most mild form of chemical fertilizer? Would you consider superphosphates as such a mild fertilizer and would such a fertilizer kill off earth worms completely? There is a fertilizer made in this country called Cyanamide. Have you ever heard of this and would you consider it a dangerous fertilizer?

10th April, 1943.

Dear Mr. Rodale.

In reply to your letter of March 4th, the drawback of superphosphate is that it makes the land acid. It has led to a lot of trouble in New Zealand for this reason. I believe it does have the effect of killing earthworms.

Calcium cyanamide used to be used a great deal in England, but the manufacture has stopped. I should certainly not recommend it for use in the United States.

Yours sincerely,
A. Howard.

March 6, 1943.

In further reference to my letter of March 4th, I have been told that Cyanamide is a by-product of the coke ovens. In this respect there are other products that some of our readers ask us about. For instance, the value of hard coal ashes as fertilizer, the use of soot from chimneys. What is your opinion of these?

Sincerely yours,
ORGANIC GARDENING,
J. I. Rodale, Editor.

Dear Mr. Rodale.

Opinions differ about the value of sifted coal ashes. Where the soils are very heavy, the small amount of grit that comes through the screen helps to keep open heavy soils, but gardeners on light soil areas are not at all in favor of anything approaching a cinder in the soil.

Soot, of course, is a most valuable manure, particularly for vegetables like onions. It is used very largely in this country and the big growers always complain that they can never get enough of it.

Yours sincerely,
A. Howard.

March 11, 1943.

Dear Sir Albert.

Wholesale grocery concerns near our farm burn up the greens representing the tops of vegetables. We could get this material for composting, but the only trouble is that we fear the poison sprays that might be on these greens. Such sprays probably are very strong, such as arsenics and mercury. Do you think it would be safe to use such green material in the compost heaps? Would the action of the heaps destroy the power of these toxic materials?

28th April, 1943.

Dear Mr. Rodale.

In reply to your letter of March 11th, I do not think there will be any danger in

composting the tops of vegetables, even if they have been sprayed with arsenical sprays. The amount used is very small and the chemical changes in the compost heap are so intense that they would in all probability destroy all these poisons.

A. Howard.

March 15, 1943.

Dear Sir Albert.

One of our readers has a problem of an extremely sandy soil to deal with. He is afraid that compost will not help his land, thinking that it will benefit only loam and clay loam soils?

April 28, 1943.

Dear Mr. Rodale.

In reply to your letter of March 15th, I think the best answer you can give your correspondent is to get him to make compost and apply it to his sandy land. This is exactly what these sandy soils require and many examples exist all over the world in which very fine results have been obtained by getting these lands really fertile by means of properly made compost. Some of the best examples our island has to show in this are to be found in East Anglia, where Coke of Norfolk during the Napoleonic Wars transformed useless sandy land into first-class agricultural areas, capable even of growing wheat. I hope, therefore, your correspondent will go all out for composting and produce results which, I am sure, will interest the readers of *Organic Gardening.*

Yours sincerely,

A. Howard.

The Petty Method

Dear Mr. Rodale.

I think the Petty method is going to prove useful. I am trying it out myself and two other correspondents are doing so on a fairly big scale. I will let you know the results as soon as they are available. In the meantime, it might be a good thing just to refer to this device in *Organic Gardening* and suggest that some of your readers in the U.S.A. try it out. The essence of the method is the provision of an air chamber connecting with the outer air by means of a pipe, so that oxygen can pass from the atmosphere into the compost heap. It is quite possible that in this way we shall be able to shorten the fermentation process quite considerably.

Yours sincerely,

A. Howard.

(Note) We described the Petty method in the April issue of Organic Gardening.

Earthworm Dept.

Questions and answers submitted by Ohio Earthworm Farms, (Worthington, Ohio.)

Q. *What is meant by Earthworm Spawn?*

A. Spawn is the culture that Earthworms are grown in.

Q. *Can Earthworms live in Clay ground?*

A. Earthworms can live in any ground, but if placed in Clay it takes them longer to work clay up, the same applies if you are served a tough piece of beef it takes you longer to masticate it and clay is a tough piece to the Earthworms.

Q. *How do you control Potato bugs and Cut Worms?*

A. Impregnate soil with Earthworms. Since using Earthworms as our means of fertilization we have had no potato bugs or cut worms. Evidently we get a life jump on these pests and we are constantly building health from the root system and plants are more disease and pest resistant.

Q. *What is meant by Earthworm Capsules?*

A. Capsules are the reproductive organism or egg that each Earthworm throws off.

Q. *Why don't your hands get rough and dirty in Earthworm infested soil?*

A. The Earthworm gives off an oil. Also soil where the Earthworm lives in abundance is alive, will not cake and you can work for hours and your hands will be nice and smooth when you wash off the soil.

Reader's Correspondence

Dear Mr. Rodale and co-workers in getting out "Organic Gardening:"

Here's something interesting! For several years I have sought to get earthworms in my fields —unsuccessfully. But having gotten the city street department to send me many loads of leaves, dumped on my fields (they were glad to do it) and the cannery to dump their tomato and other slops on my fields, and all plowed under last Fall, I rejoice to report many worms are now in my fields. "Just naturally!" Your readers can do likewise. However, I believe it best to compost the leaves till they're partly, at least, broken down, rather than plow them under "raw," as I did.

Eugene Middleton.

Answer:

There are two methods of handling such green matter. One—either thoroughly compost it to see that all material is thoroughly decayed or two —when applied to the land direct, before composting, be sure the land is not used until material is thoroughly decayed, which may take more than one season.

■

Organic Gardening
Dear Sir:

Was greatly interested in your letter regarding organic fertilizing as the use of commercial fertilizer over a period of years has caused the ground on our two acre avocado grove to become hard and barren instead of building it up as it should have if we had more humus in the ground.

I moved here a year ago to see if I could bring the grove back into a producing one and in spading in the weeds and leaves to break up the hard crust, as we have a sprinkling system and cannot have it cultivated, I found no earthworms or other life in the soil. The trees are eighteen years old and the falling leaves in all those years should have caused a natural mulch but the ground is as barren and hard, as it is a sandy loam, as can be. It is in worse condition than when we first planted the trees. Am anxiously awaiting your magazine.

Olive F. Wheeler,
Carlsbad, Calif.

■

Earthworms and Chickens

I got my chicks out at 6 and one-half weeks, 1¾ — 2 lbs. live weight—broilers. You may remember I wrote you a short time ago. In my letter to you, I said I was getting worms from my compost to feed the chicks. That is not all I did but to get broilers out at 6½ weeks for market purposes is something to brag about. They are heavy birds at that. Well I hope I get more such ideas.

Sincerely,
Mrs. D. Juttner,
R. 3, Park Dr.,
Corvallis, Oregon.

■

Organic Gardening:

I have read with considerable interest your March issue of Organic Gardening, especially as to the Compost building. Not only do I raise some vegetables, but I specialize in Camellias and Azaleas, which prefer an acid reacting soil. Inasmuch as your Indore Process turns out an Alkaline humus, what should I do to make it acid?

Another thing, the San Francisco Sulphur Company puts out a "Toro Brand of Agricultural Sulphur Compound, consisting of 85% pure Sulphur and 15% of other valuable soil correctives such as Calcium Carbonate."

Please let me know what your reactions are and whether this sulphur would be good for my soil, much of which is of the heavy-adobe-clayey type. What would you recommend I use to improve and keep it broken up, etc.

Yours very truly,
Louis J. Macchai,
San Francisco, Calif.

Dear Mr. Macchia:

Regarding your Camellias and Azaleas which prefer an acid reacting soil, it probably would be best to use purchased peat humus, which is acid. The compost that we make on our farm is alkaline.

We do not recommend sulphur products in connection

with farming and vegetables. We do not recommend coal ashes as it is too strong. We have heard of a farmer who used sawdust bedding after it was impregnated with urine of cows, which seemed to destroy its acidity. By the way, sawdust is acid and you might try some of that for your flowers.

By plowing under sawdust, you will be loosening up your soil. Other acid materials are oak leaf mold, loose soil taken from the woods, which consists of rotted leaves. Also, dried blood mixed with 25% cotton seed meal gives an acid reaction.

■

Dear Sir:

Farmers' Bulletin No. 1568 says to burn all rabbit manure to prevent infection of all kinds. (Well that is quite a waste). Please answer.

J. M. B.

Dear Sir:

It is safe to use your rabbit manure, but be sure and compost it carefully so that the heap is turned several times as instructed.

Farmer's Bulletin No. 1568 was evidently not aware of the fact that one can compost manure. To use it raw would be dangerous and that is what they were thinking. The government has as yet not experimented sufficiently with compost heaps to be able to advise in such cases.

■

Gentlemen:

Can seeds and plants prepared by natural methods be purchased?

M. A. Mayer,
Norristown, Pa.

Dear Sir:

Replying to your letter of April 28th, you can purchase humus and peat moss. Get in touch with the Hyper Humus Co., Morris Bldg., Philadelphia, Pa. You will find that their humus is a little acid and should be mixed with lime.

Regarding whether you can purchase seeds and plants prepared by natural methods, we have as yet not made a survey, but we doubt very much if such seeds can be obtained.

As the circulation of our magazine increases and the demand grows, I believe that someone will start producing natural seeds for this market. At the present time it is too early yet to be able to purchase such material.

■

Dear Sir:

There is a problem that is worrying me that you may be able to advise the best procedure without having to resort to poison.

Certain parts of my lawn are infected with cut worms. They are about an inch long when straightened out. Usually they are curved when found. They are gray in color and about one-fourth inch thick.

I find they are cutting the grass at the roots. Have been advised by a local garden supply store to apply poison but after reading your magazine I hesitate to apply it as it might be worse than the cure.

Elmer F. Brunner,

Dear Mr. Brunner:

Regarding your problem of the lawn, usually the condition you describe is brought about by having followed artificial methods which has interfered with nature. The real treatment, therefore, would be to change back to natural methods and gradually bring back a healthy condition in the grass bed. Grass likes to have the soil slightly acid. We would suggest, therefore, that you purchase peat humus from some nursery concern and apply the humus liberally to the lawn. Many persons make the mistake of putting lime on the lawn which is alkaline, whereas for good grass, it should be slightly acid. The peat humus that we suggest, which is a sort of dark brownish black color, will be absorbed in a short while.

■

Dear Sir:

What do you think of using sawdust for mulching the garden, especially strawberries. We were on the point of using it once but upon inquiry at the State University they told us it was not satisfactory and that it would make the soil acid. That was several years ago. It was recommended to us by a dairyman of Wisconsin who used it for mulching strawberries. I should think it O. K. because it is a vegetable product whether pine or other timber. We can get both, old or new sawdust. What do you think?

Also why is "gypsum" not good for the soil. What element is not good?

Yours truly,
Melvin Hallett,
Hackensack, Minn.

Dear Mr. Hallett:

Replying to your letter, sawdust is excellent for mulching in the garden where an acid condition is desired, such as for rhododendron and the evergreens. This would be excellent for strawberries also. Strawberries may be grown either with slightly acid or slightly alkaline conditions, but they favor more the acid.

You will find an article in the May ORGANIC GARDENING about a farmer who successfully used sawdust for a period of over 20 years on his farm. In compost heaps, sawdust may be used as part of the green material and when it breaks down in the heap, the general condition of the heap will be alkaline. It is only in the raw condition that sawdust is acid.

We do not recommend gypsum because of its sulphur content. It is not a substitute for lime because the use of gypsum makes the soil acid whereas lime is used to bring about alkalinity.

■

Mr. J. I. Rodale, Editor:

As you are probably aware, I am, after receiving and reading five editions of your magazine, an enthusiastic proponent of organic gardening. So much in fact, that at times I can think of little else. The matter of properly grown, vitamin-filled foodstuffs, to my mind, is of such vital importance that people "in the know" should waste no time at all in scattering far and wide in the shortest possible time the information that we needn't depend upon artificial chemical fertilizers and poisonous sprays to raise bountiful food crops. The best way I know to get this information to the public would be to increase the circulation of your magazine. I have in mind a plan I submit for your consideration.

Suggest printing a small pamphlet somewhat as follows:

WHY ARE WE A SICK NATION?

In this country more doctors and nurses are available and more hospitals, clinics, health resorts and sanitariums are at the disposal of the people than in any other country in the world. Why then, so much sickness? You and I know of hosts of people who are not well despite all kinds of medicines, treatments of various kinds and, last but not least, the taking of so-called vitamin tablets. The following excerpts taken from articles appearing in "Organic Gardening" shed a great deal of light on this question.

(I have many excerpts in mind that could be printed here).

WHAT CAN WE DO ABOUT IT?

(Many excerpts come to mind that could be used here).

At the end of the pamphlet could be a subscription form or, after the first mention of Organic Gardening above, "Emmaus, Pa." might be placed in parenthesis and this would furnish an address to which interested persons could write.

Every day someone around here is talking about an ailment or someone who has an ailment and I suppose it is that way everywhere. Such occa-

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At the last moment when you are ready to put in those radishes, are you in doubt about some important information as to how to apply humus, depth of planting, width, etc. Do you rush into the house and spend precious quarter-hours poring through encyclopedias or other books? Here is your answer.

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Box C-5 Roscoe, Calif.

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ORGANIC GARDENING
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Gentlemen:

Enclosed is $2.00 for one year subscription (10 issues) to Organic Gardening.

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sions are ideal for handing out such a pamphlet as described. They could also be placed at locations frequented by farmers. I would be pleased to help in the distribution of such literature and even help pay for the printing of same.

Sincerely yours,
F. E. Callaghan,
Windber, Pa.

Dear Mr. Callaghan:

As part of our program we intend to print a pamphlet for general distribution, but due to restrictions on paper, we cannot do it right away. Your suggestion gives us the idea of getting up a letter which we could furnish to some of our readers who would like to send them to friends and acquaintances, suggesting a subscription to our magazine. We will see whether the publishing of this letter in ORGANIC GARDENING will bring requests from other readers for such a letter.

We would like to establish a laboratory to test for vitamins on food products grown under varying conditions, but this requires considerable money and it is difficult now, due to war conditions. If the magazine grows sufficiently it might be able to support such a laboratory.

■

Gentlemen:

Do you think that earthworm spawn bricks would be practical to use in New Jersey clay loam soil?

A. J. Ball,
Bloomfield, N. J.

Dear Mr. Ball:

The type of soil makes no difference as earthworms will work in almost any soil if given the right conditions. A Spawn Brick is a quantity of earth, compost, etc., containing earthworms which are breeding in it.

We received two boxes of the Spawn material and are breeding the earthworms in our cellar. In our opinion, at this stage, we think it would be more economical and more practical for you to raise the earthworms first, and when you get to the point that their supply is large enough, you could then apply a certain amount to your soil. We think you will find it very expensive to apply the purchased Spawn material to your soil.

■

Poultry

Regarding earthworms and chickens the following might be of interest to you. Late in 1941 we did some grading in an old buck (goat) pasture which yielded a lot of worms. It so happened that we had several birds which for some reason had lost the proper use of their legs. We disposed of all but three which we put on a worm diet. Two recovered after about two weeks if I remember correctly; the other bird was either accidentally killed or butchered I forget which. It would be interesting to know if one of your readers had similar experience along those lines.

Very truly yours,
A. F. A. Konig.
Newtown, Conn.

(Continued from inside front cover)

to get on with so little phosphate. It was disclosed by a detailed study of the roots of trees, an investigation which lasted ten years, the results of which are referred to in Chapter 9 of *An Agricultural Testament*. The deeper roots of the trees, which are so abundant all over "The Garden of India", comb the soil down to twenty feet for minerals which are carried up to the foliage in the sap current, finally reaching the surface soil in the form of humus made from the dead leaves. The trees are the agents devised by Nature for the circulation of such things as phosphate and potash for the benefit of crops. Suitable methods of composting would convert the various residues into humus which the soil organisms finally prepare for the use of plants. The important point is, therefore, not the total quantity of this or that in the soil, as disclosed by chemical analysis, but the condition —whether organic or inorganic —which enables things like phosphate to be effective. The phase is obviously immeasurably superior to the inorganic, because the former suits the soil organisms and the crop, while the latter is only so much raw material out of which plant food has to be synthesized in the soil itself.

May it not prove that the solution of the phosphate question in New Zealand will be found on lines suggested by the above rather than by the importation of phosphate rock and its preparation in a factory? Would it not be an advantage to the country to go into the phosphate problem anew, remembering that the chemical aspect is likely to be the least important, that the biological side is probably the most important, and that adequate attention should also be paid to the physical factors involved?

In carrying out the investigations so obviously needed I suggest full use be made of the animal. The live stock should be allowed a free choice between one half of a field manured with superphosphate and nitrogen, the other with an equivalent amount of freshly prepared humus. If the above reasoning is correct, the grazing animal will show a marked preference for the humus plot and neglect the one manured with the products of a chemical factory. The matter could then be carried further. On two farms on similar land, the one manured with NPK, the other with freshly prepared humus, the well-being of the two sets of live stock could be compared as regards the production of meat, milk, and the health of the progeny. The NPK farm is certain to lose.

The cutting off of the usual supplies of superphosphate by enemy action and the substitution of serpentine superphosphate may in the end prove a blessing in disguise. It may draw pointed attention to the great need for the farms of New Zealand to be self-supporting as regards manure, to the use of deep-rooted trees for keeping what phosphate there is in effective circulation and for the centennial rotation between forestry and farming. It might easily pay New Zealand in the future to convert every year say one per cent of the grass area into forest and to bring a similar area of forest back into grass. There is nothing like the forest for cultivating the subsoil and for adding to the store of humus in the soil. Another device for helping existing grassland might be the use of the subsoiler of the wheel type similar to that used by the late Sir Bernard Greenwell in England. I am enclosing a copy of his paper to the Farmer's Club on January 31st, 1939. It might prove of great value to New Zealand agriculture.

One final point: I gather from Mr. Holford's paper that in the manufacture of serpentine superphosphate the acid phosphate is reverted. If this reversion is complete, it might happen that serpentine superphosphate will *not* have the same effect on the grass as an equivalent dressing of superphosphate. Such an experiment should be tried without delay. If the effect of superphosphate in New Zealand is to a large extent an indirect one in flocculating the colloids, then this manure will be much more effective than a dressing of serpentine superphosphate. Such a trial therefore might at once break new ground in this phosphate question.

To sum up: there is no justification whatsoever for the current view in New Zealand that compost cannot solve the phosphate problem. I think it will at least help. The arguments against this opinion are obviously dictated either by a superficial consideration of the subject, or what is more likely by some vested interest connected with or under the thumb of the artificial industry. An interesting problem awaits solution. For this the man is everything, the rest is nothing.

AN AGRICULTURAL TESTAMENT

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